A Nuclear Power CM Historical Perspective

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Configuration Management (CM) existed to varying degrees in the military, at NASA, and in the aerospace/aircraft industries from the late 50's and early 60's. These CM programs were geared towards product conformance to facilitate interchangeability of parts while still satisfying the overall design requirements. In the early years of the commercial nuclear program (mid 60's to early 80's), there was little thought given to long-term configuration management. The design focus was primarily for the Architect Engineer (AE), who was typically a contracted agent of the utility, to design the plant and create drawings and specifications so that equipment could be procured and construction activities completed as quickly and economically as possible. The Architect Engineers were concerned with meeting design requirements and producing output documents that could be used by the Construction forces to erect the physical plant within the utility's schedule. As required by regulations, there were design controls in place to ensure that field changes or other change mechanisms were reflected in the final design documents. Documentation of the design bases, the calculations and the evolution of the design was sketchy and rarely maintained in a manner which could be used by an outside company or agency.

The final design documents were typically turned over to the utility en masse at the end of construction. The inherent knowledge of the design basis and sense of ownership of the design were not effectively transferred with the documents. The utilities were neither experienced nor equipped to deal with long term design maintenance and related document upkeep. The plant engineering staffs had their hands full trying to keep the plant online and operating properly. In most cases, the utility retained the AE's services beyond commercial operation for design support, but there was little or no knowledge transfer of the design information to the utility engineering organization. Furthermore, since most utility engineering organizations were located in the corporate offices away from the plant, this distance further separated the design basis considerations from those necessary to keep the plant operational.

Some early indicators that the nuclear plant design basis knowledge was becoming disconnected from the physical plant began to appear in the late 70's. One of the first large-scale indicators was NRC IE Bulletin 79-14[(1)], which dealt with problems NRC Inspection and Enforcement division inspections had observed between the piping and structural analyses and the physical plant installation. Numerous instances were noted where the configuration shown on piping stress diagrams did not match what was actually in the field or described in the FSAR. When the utilities did their own assessments, they found calculation discrepancies, undocumented modifications, discrepancies between different documents, and a host of as-built problems to resolve. Many utilities spent tens of millions of dollars to walkdown their piping systems, re-analyze structural loadings, and correct and re-draw plant drawings.

The second significant indicator resulted from an anticipated transient without scram (ATWS) event at the Salem Nuclear Plant in New Jersey on February 25, 1983. Beyond the specific technical issues associated with how plants dealt with ATWS events and reactor trip breaker problems, there were generic implications identified in NUREG-1000(3) and NRC Generic Letter 83-28(2) which addressed plant compliance with vendor recommendations, part and procurement issues, and vendor manual controls. As a result, there were numerous industry initiatives by INPO, NUMARC and EPRI to provide guidance and consistency to address these issues.

On June 9, 1985, another industry event became a precursor to CM becoming a "household" word for nuclear plants. The Davis-Besse plant in northern Ohio suffered a loss of feedwater event that eventually resulted in the NRC conducting a number of in-depth Investigative Team evaluations of other plants. These evaluations led to the establishment of NRC Safety System Functional Inspections (SSFIs) and the issuance of NUREG-1154(4), which identified that utilities were having difficulties maintaining the operational readiness of their safety systems and did not truly understand the design bases of their plant. These shortcomings in compliance to design and licensing bases were associated with the utility's inability to define the system/component functions and the basis for the design. This realization caused many utilities to voluntarily begin an extensive (and expensive) Design Basis Reconstitution effort. Many utilities used the Design Basis Documents (DBDs) to perform self-evaluations, modeled after the NRC's SSFIs, to evaluate the accuracy of the DBDs and plant compliance to the design basis.

As with the aftermath of the Salem ATWS event, the Davis-Besse event created a flurry of industry initiatives and documents produced on the proper way to go about reconstituting the plant design basis. Among the documents produced were NUREG-1397(7) and NUMARC 90-012(8). As the Design Basis reconstitution efforts got underway, the industry began to realize that the design basis is a foundation for configuration management. This realization was evidenced in the magnitude of the problems that were being seen from the long-term lack of configuration management. There were also serious questions about how the information being developed to produce the Design Basis Documents (DBDs) would be kept up to date in the future. Other documents emerged to begin addressing the CM issues, for example INPO 87-006(6) and NUREG/CR-5147(5).

These issues were in the foreground of the Nuclear Information and Records Management Association (NIRMA) Configuration Management committee that met in 1989 to produce the guideline document PP-02(9). This committee was composed of both utility and consultant representatives who were experienced in many disciplines ranging from engineering design to plant operation to records management and document control. The committee recognized that the solution to the Configuration Management issue was a combination of the control of technical information by the engineering and operations personnel and the reliance on a mature records management and document control process to provide the needed information to the engineers and operators. Thus NIRMA, with its knowledge of the records program requirements took the lead in developing a CM guideline. The CM principles developed for NASA/aerospace in the 1960's were modified to reflect the needs of the nuclear power industry and resulted in the release of PP-02. Subsequent committee work developed a number of daughter documents to supplement PP-02.

The NRC continued to have its misgivings about whether utilities actually understood their plant's design basis and whether the design basis information was reflected in licensing documents. The NRC performed specialized SSFIs for safety systems that had generally been found to have design basis problems, such as Electrical Systems (EDSFI) and Service Water Systems (SWOPI). Further, the NRC had concerns about the extent that design basis and licensing information was translated into plant operating, maintenance, and surveillance testing procedures and practices. On August 10, 1992, the NRC published draft policy statement (SECY-92-193) in the Federal Register(10) that expressed their concern and indicated that a generic letter would be issued to require utilities to address how they were dealing with the problems. Due to pressures and assurances from the industry that utilities did have a firm handle on these issues, the NRC withdrew its proposed policy statement and intent to issue a generic letter in late 1993(11).

In 1994, one of the events that began to crystallize CM within the nuclear industry was the first meeting of what later was called the Configuration Management Benchmarking Group (CMBG)(15). Pennsylvania Power & Light convened the first meeting in October, 1994 to determine if any other utilities were experiencing the same CM-type problems they were and, if so, what successes had there been at dealing with them. There were 35 attendees representing 19 utilities at the first meeting. The benchmarking and networking begun at this first meeting has continued since with a different utility hosting the conference for each of the following years. At the 1998 CMBG Conference in Boston, the attendance was 152, with representatives from many nuclear facilities in the US and other countries.

Somewhat in parallel with the emergence of the CMBG was the work being done by the NIRMA CM Committee to produce TG19-1996(12). This document built on the NIRMA PP-02 document and presented the elements and attributes that facilities needed to establish of a good CM program. During 1998 and 1999, NIRMA TG19-1996 was processed for adoption as an ANSI standard.

Another watershed event for CM was the shutdown of the three Millstone units in Connecticut in early 1996. One of the primary contributors to the shutdown was that the NRC had lost confidence in Northeast Utility's ability to know and maintain it design basis and to implement design and licensing requirements into the physical plant and the plant procedures and documents. These NRC concerns led to the issuance of a 10CFR50.54(f)[13] letter in November 1996 to all utilities that required a response within 120 days on how the design basis information was controlled and maintained. This letter had more far-reaching implications than the letter that the NRC was persuaded not to issue in 1993.

The 10CFR50.54(f) letter forced utilities to address configuration management issues when drafting their responses. For many utilities, there was a realization that just writing DBDs was not sufficient to address the NRC's root concerns. After the utility responses were submitted, the NRC instituted a series of intensive Architect Engineer inspections to determine the correlation of the responses to the utility's design basis program effectiveness. After 16 of these AE inspections, the NRC issued Information Notice 98-22[14] that presented their results and conclusions. In summary, the majority of issues identified resulted from errors in the original design or design modifications, calculational errors, inadequate corrective actions, inadequate testing, and documentation discrepancies.

One of the side benefits of the 1996 10CFR50.54(f) letter was that it helped to solidify the CMBG as a viable resource for the industry and demonstrated how the CMBG "network" could be used to find and distribute valuable CM information between utilities, including good practices and lessons learned.

As the industry stands near the middle of 1999, CM is being implemented in a variety of ways with a wide range of resource allocations and a diverse spectrum of results. The good news is that the need for CM is more recognized and the concept of CM is more widely understood (or at least used in conversations). The bad news is that the benefits of having a good CM program are often intangible or realized as cost avoidances, instead of as a positive, visible and measurable indicator of appropriate design and operational controls. Therefore, when things are going well and there is a push to reduce overhead, CM sometimes results in staff reduction/realignment or reduction of program emphasis, with the resulting loss of design and design basis control. This usually produces cyclic CM performance, which can end up costing more in repair and "get-well" efforts than would have been required to maintain a steady emphasis on the program.